

Space-Time Variability in UTLS Chemical Distribution Associated with the Asian Summer Monsoon (ASM) and Process-Based Retrieval Information Content Evaluations

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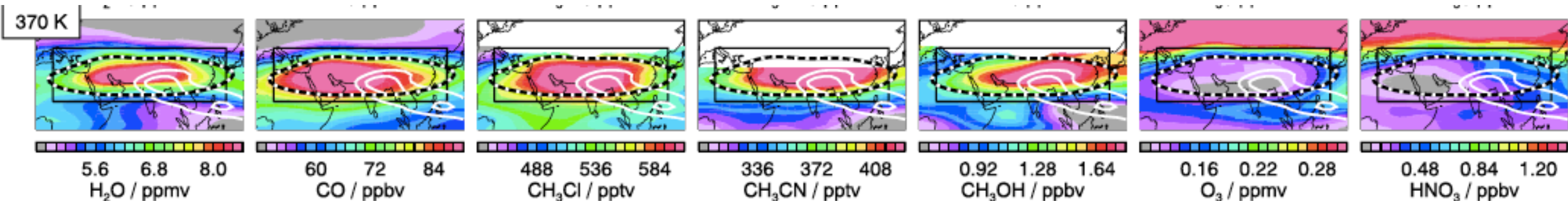
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UTLS transport by the Asian Summer Monsoon (ASM)

Questions:

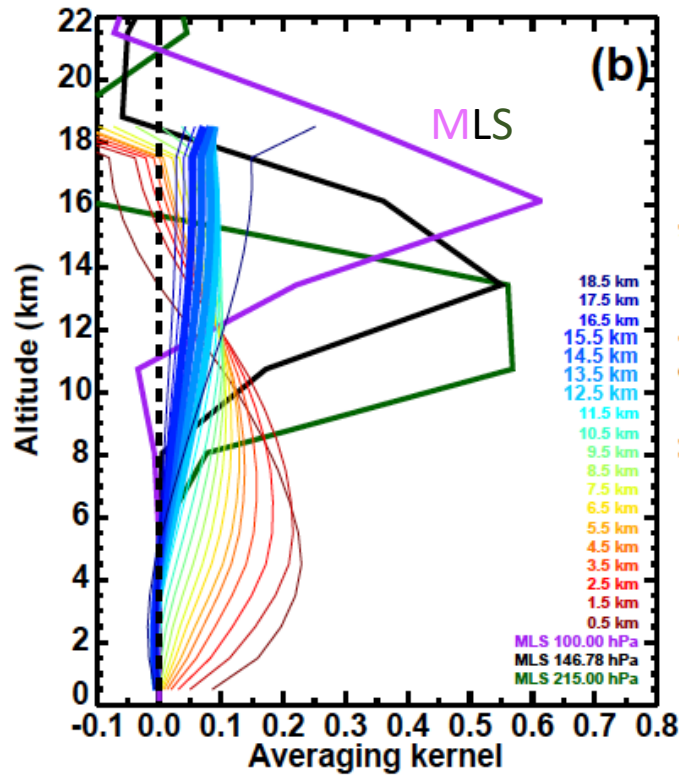
- How well do the satellite data represent the **sub-seasonal scale** or the day-to-day variability in the UTLS trace gas distribution over ASM?
- In what aspects the limb viewing sensors (**MLS** in this case) and nadir viewing sensors (**OMI** and **IASI**) may complement each other in their information content for the ASM transport studies?
- What can we learn about the **retrieval information content** based on the variability of UTLS CO and O₃ associated with the ASM dynamics?

Santee et al., 2017



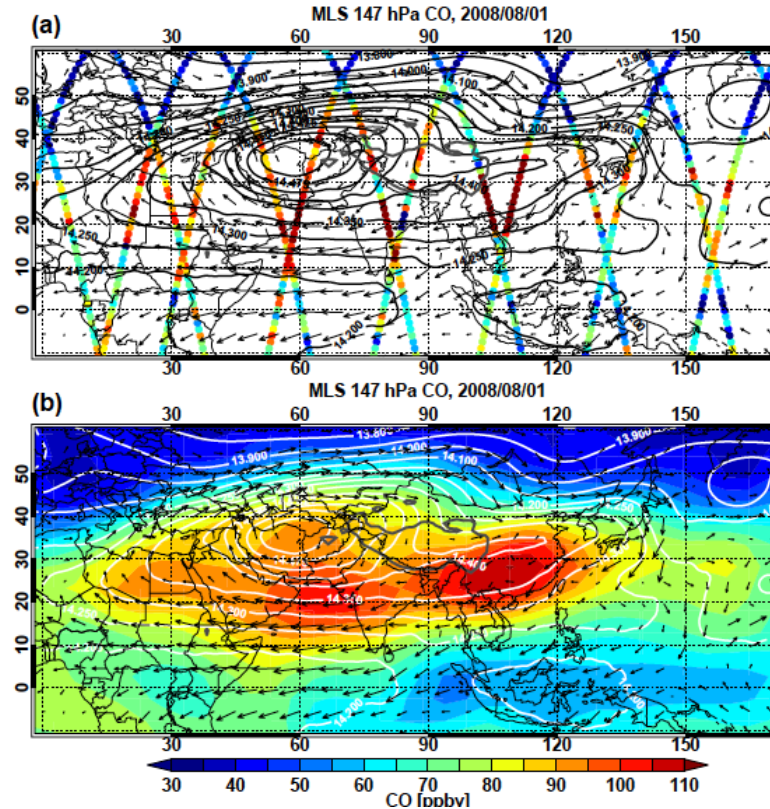
Could the limb viewing sensors (MLS) and nadir viewing sensors (OMI and IASI) complement each other ?

Averaging kernels of MLS and IASI CO retrieval



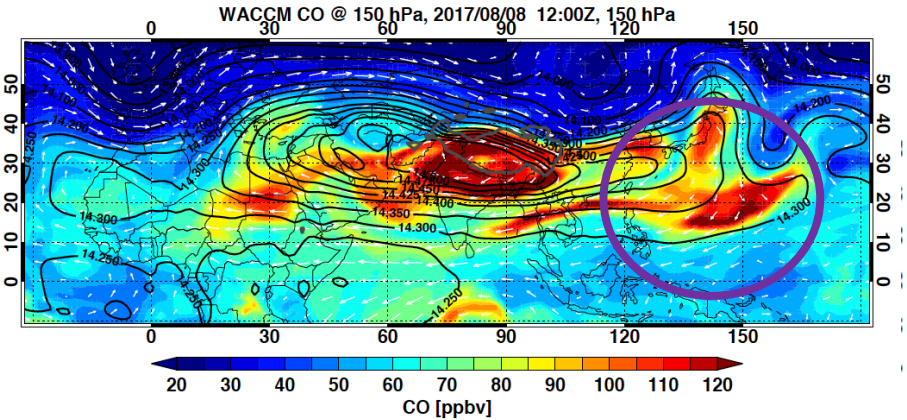
“Vertical” information content

MLS, CO 147 hPa

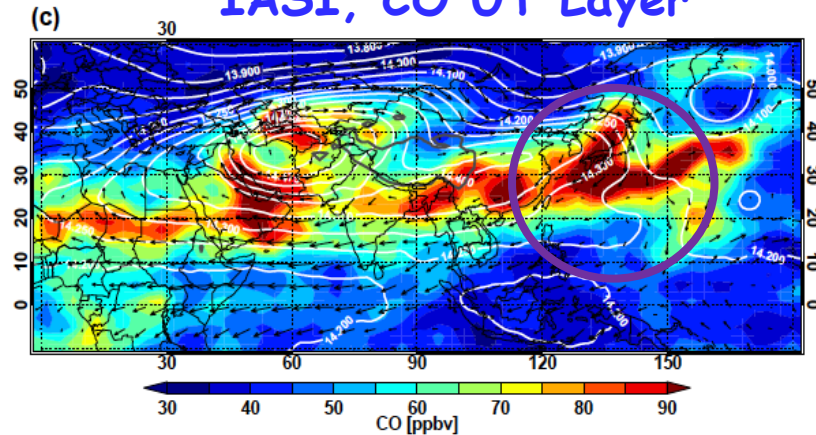


“Horizontal” information content

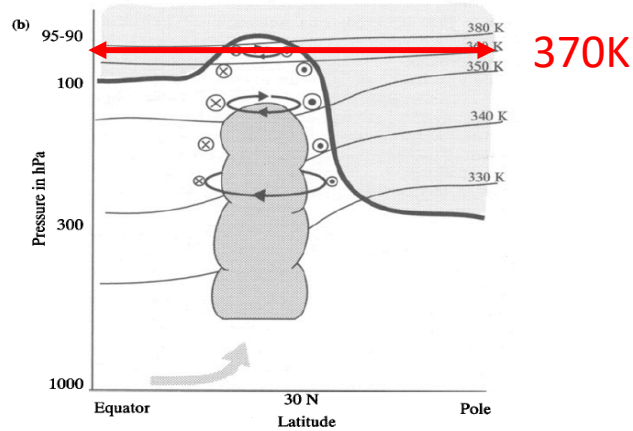
WACCM CO 150 hPa



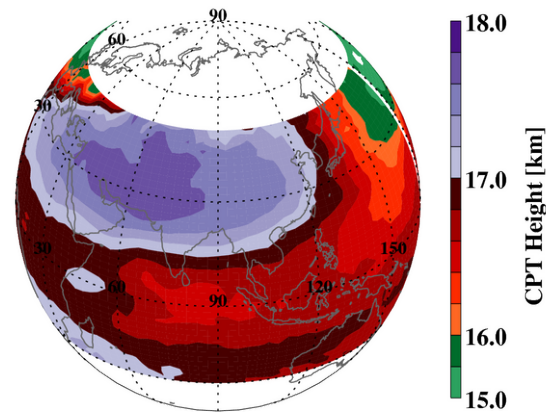
IASI, CO UT Layer



Does the nadir sensor OMI O_3 profile product have enough information to resolve the tropopause structure over ASM?

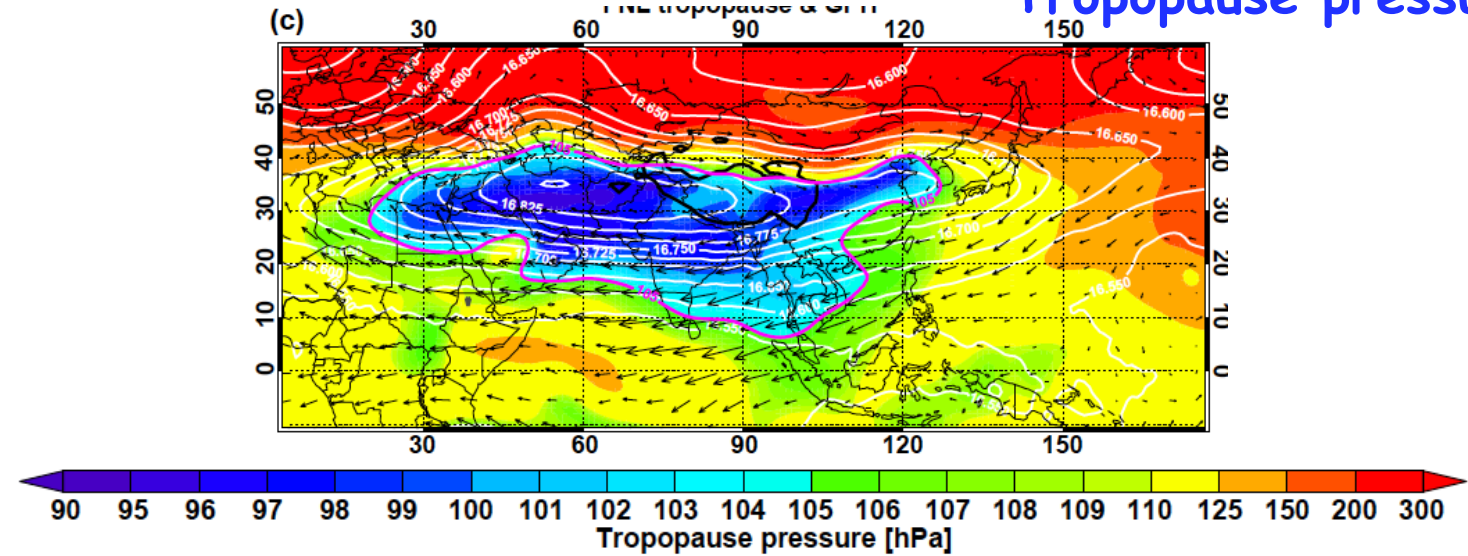


Dethof et al, 1999;

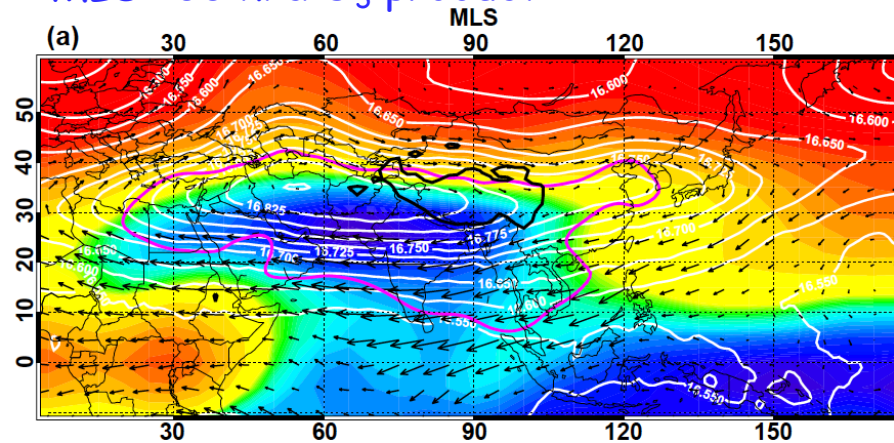


Munchak and Pan, 2014;
Pan et al., 2016

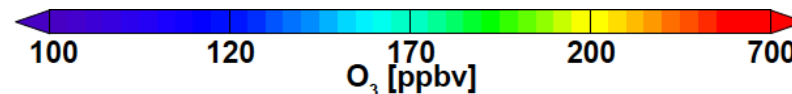
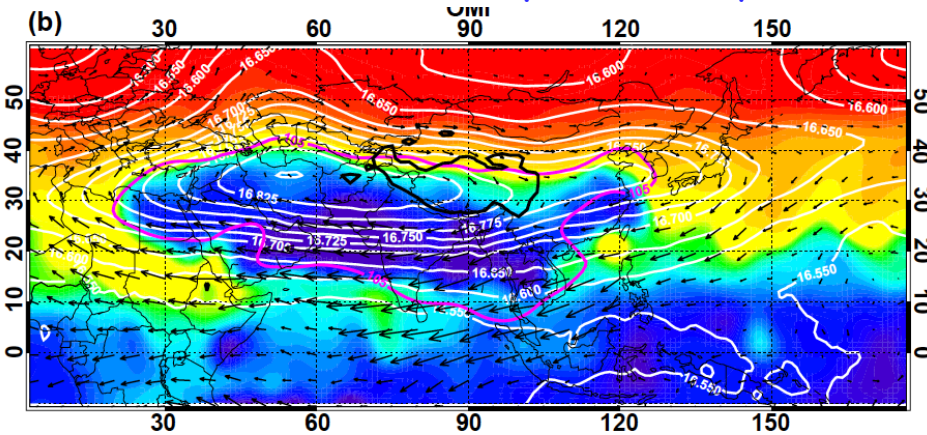
Tropopause pressure



MLS 100 hPa O_3 product



OMI Profile product Layer 18



Luo et al., ACP, 2018

Information content from averaging kernel point of view vs. from process-based point of view

Averaging kernels of OMI profile retrieval

based point of view

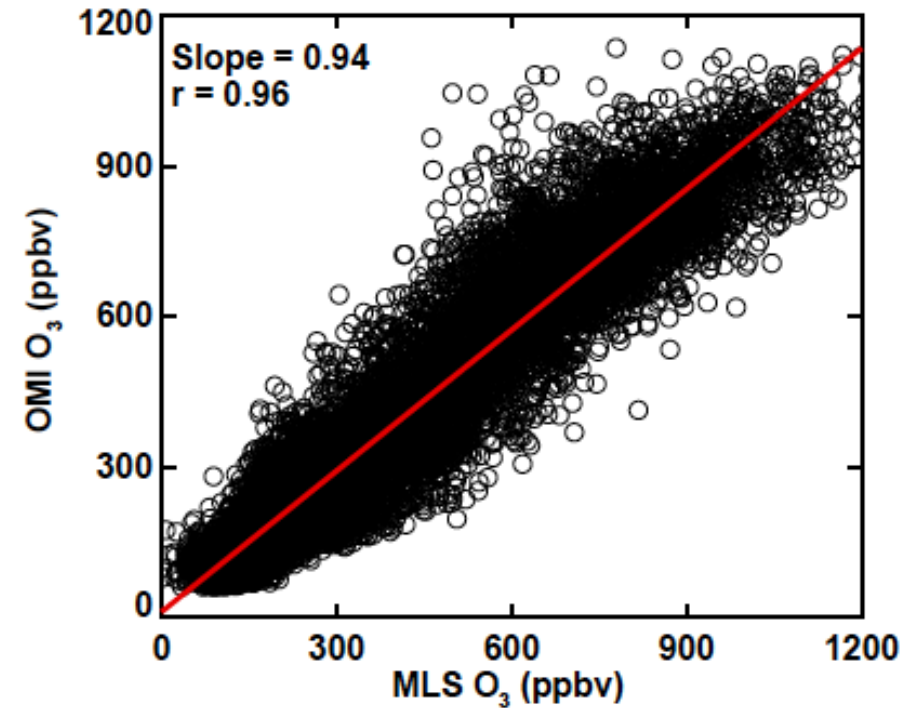
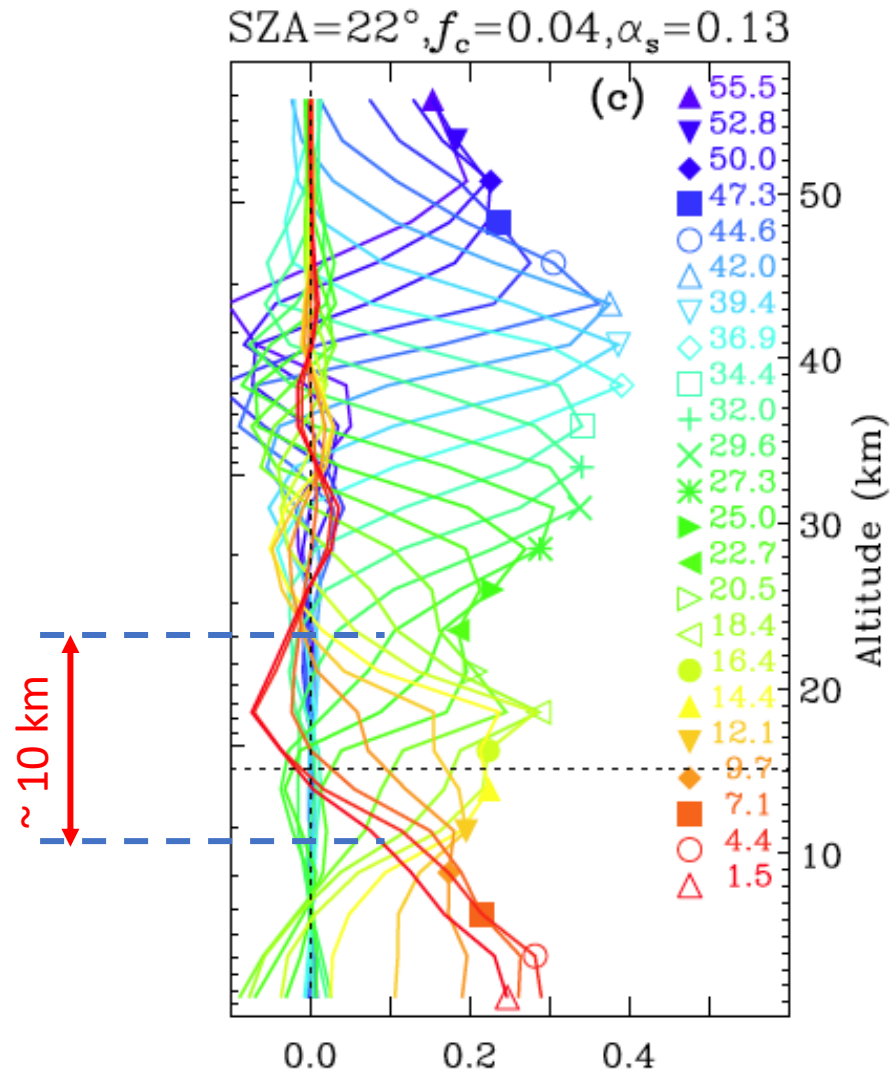
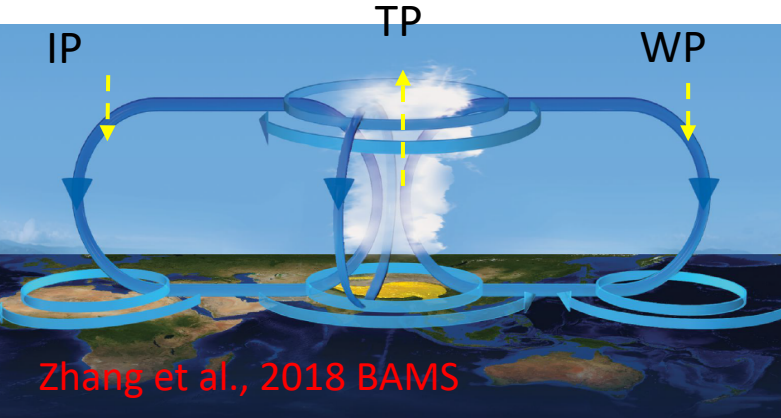
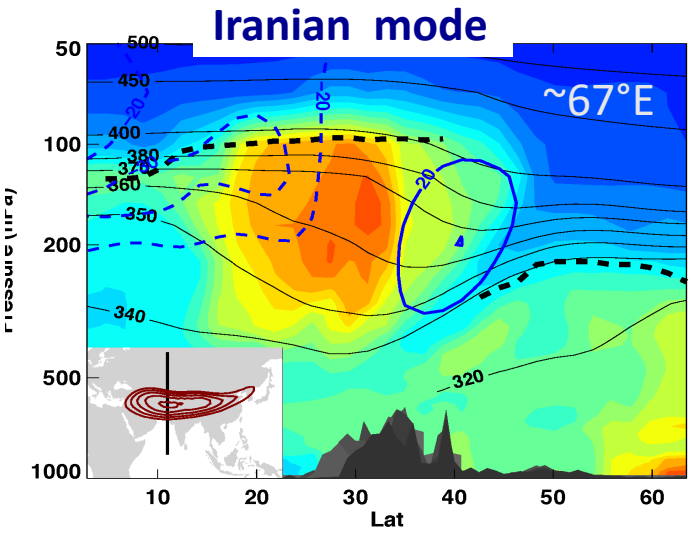
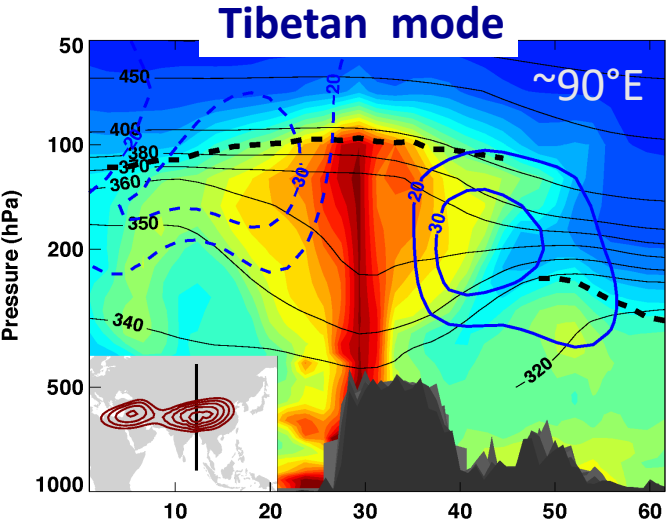


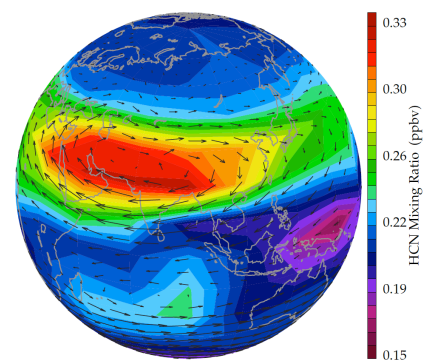
Figure 12. Same as Fig. 3 but for the OMI layer 18 O_3 mixing ratio versus the MLS O_3 mixing ratio at 100 hPa for JJA 2008. The red line shows a linear fit. Correlation and slope for the linear fit are given in the upper left corner of the panel.

Sub-seasonal scale structure of ASM UTLS flow

Seasonal average perspective of the ASM UT anticyclone

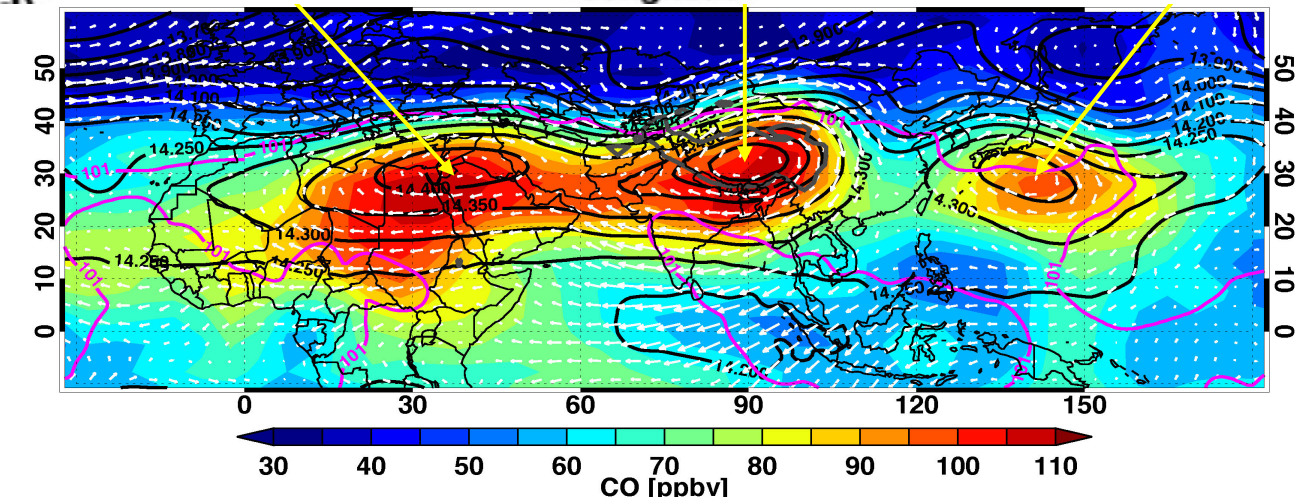
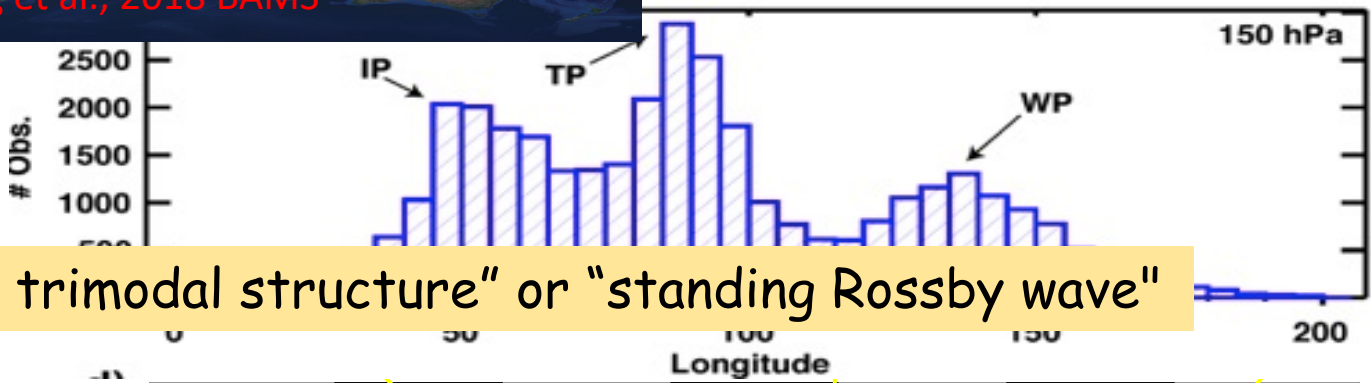


from JJA HCN from ACE
Randel et al., 2010



Honomichi and Pan, to be submitted

"A trimodal structure" or "standing Rossby wave"



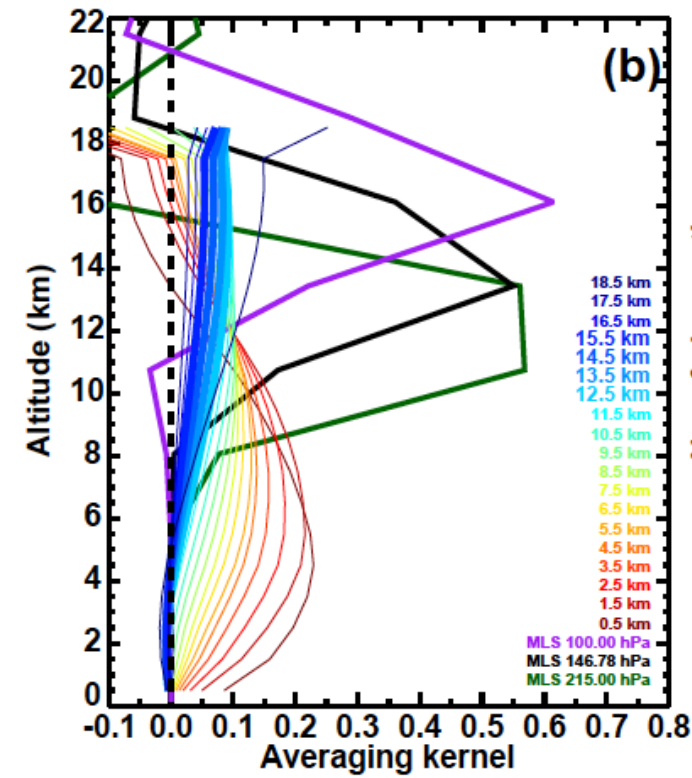
WACCM CO

Pan et al., 2016

Does the nadir sensor (IASI) have enough information to resolve the upper tropospheric CO?

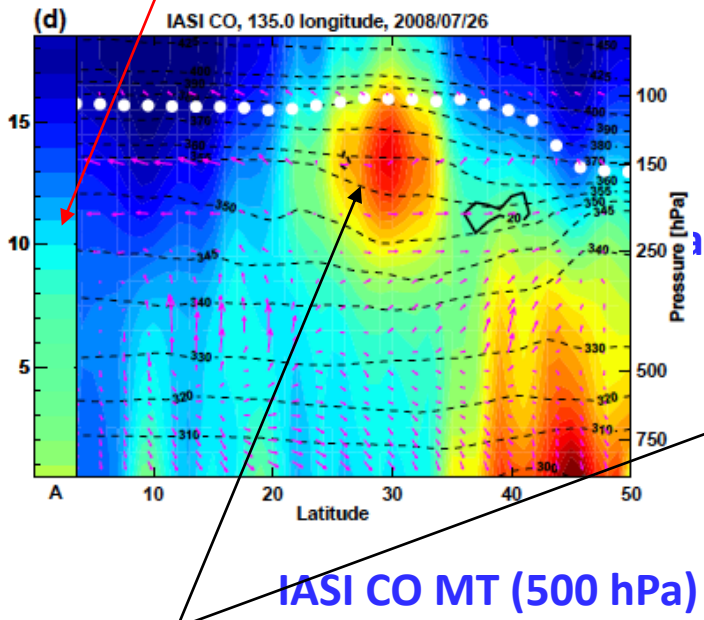
“Process-based information content evaluation”

Standard method: “Averaging kernels”
and “degree of freedom in the signals”



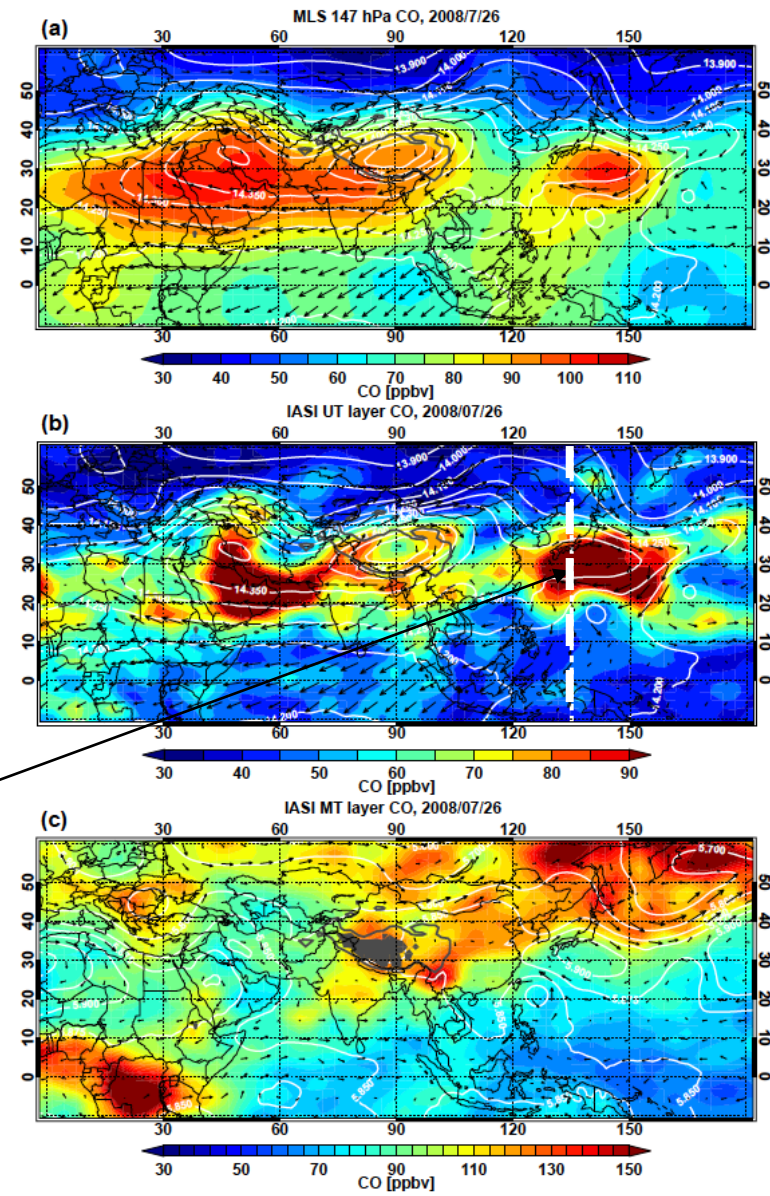
MLS CO 147 hPa

A priori profile



“Western Pacific Mode”

Luo et al., ACP, 2018



The only observation evidence so far that support the model result !



Asian Summer Monsoon Chemical and Climate Impact Project (**ACCLIP**)



Primary Goal: To investigate the impacts of Asian gas and aerosol emissions on global chemistry and climate via the linkage of Asian Summer Monsoon (ASM) convection and associated large-scale dynamics

Co-Principal Investigators: Laura Pan (NCAR), Paul Newman (NASA)

Co-Investigators: Elliot Atlas (Univ. Miami), William Randel (NCAR), Brian Toon (CU), Troy Thornberry (NOAA)

Members of Scientific Steering Committee: Ru-shan Gao (NOAA), Michelle Santee (JPL), Stephan Borrmann (MPI), Markus Rex (AWI), Masatomo Fujiwara (Japan), Eric Jensen, Karen Rosenlof (NOAA)

Location: Western Pacific (Flight Operations from Japan) **Dates:** July 15 – August 31, 2020

